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# Freshwater sponges (Porifera, Spongillidae) from the Lake of Geneva, Switzerland

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**Freshwater sponges (Porifera, Spongillidae) from the Lake of Geneva, Switzerland. -** A census of the sponge fauna in shallow-waters of the Lake of Geneva, Switzerland, displayed the presence of scattered populations of *Spongilla lacustris* (Linnaeus, 1758), *Eunapius fragilis* (Leidy, 1851), *Ephydatia fluviatilis* (Linnaeus, 1758), and *Ephydatia muelleri* (Lieberkühn, 1855). *Spongilla lacustris* was the most frequent species, either alone or associated with other species it was present in numerous sites on a variety of substrata along the entire shoreline. The morphological analysis of specimens of *S. lacustris* of the Lake of Geneva compared with the type material of *S. lacustris* and *Spongilla helvetica*, shows a considerable variation of skeletal and gemmular characters. Therefore, the synonymy of *S. helvetica* with *S. lacustris* is confirmed. The study also demonstrates the existence of a rich and diversified sponge fauna in the Lake of Geneva.

**Key-words:** *Spongilla lacustris* - *Spongilla helvetica* - Lake of Geneva (Lac Léman) - freshwater sponges - distribution - morphology - biodiversity.

## INTRODUCTION

Five species of spongillids are actually known from Switzerland (see map): *Spongilla lacustris* (Linnaeus, 1758), *Eunapius fragilis* (Leidy, 1851), *Ephydatia fluviatilis* (Linnaeus, 1758), *Ephydatia muelleri* (Lieberkhün, 1855) and *Trochospongilla horrida* Weltner, 1893. Only four of them are presently known to occur in the Lake of Geneva. *Trochospongilla horrida* has only been reported for the Lake of Neuchâtel. Annandale (1909) described *Spongilla helvetica*, from the Lake of Geneva with no other records from other localities. This species was considered doubtful by some authors (cf. Arndt 1926; Gee 1931, 1932). Jorgensen (1946), referring only to the description of thin-walled gemmule, considered *S. helvetica* conspecific with *S. lacustris*. Penney & Racek (1968) suggested a close affinity between *Spongilla helvetica* and *Spongilla lacustris*, but in view of the paucity of the material examined by them, they considered advisable to retain *Spongilla helvetica* as an available species. After the study of a paratype of the species, Ezcurra de Drago (1972), considered *Spongilla helvetica* conspecific with *Spongilla lacustris*.

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In this work, we studied type material and different populations of *Spongilla lacustris*, paying particular attention to the morphology of the gemmules, by making a SEM analysis of the gemmule structure of the neotype of *S. lacustris* (Figs 5-10) and of the paratype of *S. helvetica* (Figs 11-16). At the same time, the spicular morphology and micrometry of specimens formerly identified as *Spongilla lacustris* and *Spongilla helvetica* from different localities in Switzerland, were analysed (Table 1). In addition, we include here the results of a species census for the Spongillidae represented at different localities of the Lakes of Geneva and Neuchâtel (see map).

## MATERIALS AND METHODS

### Abbreviations

IZUG = Istituto di Zoologia dell'Università di Genova;
LEBA = Laboratoire d'Ecologie et de Biologie Aquatique, Université de Genève;
MHNG[1] = Muséum d'histoire naturelle, Genève;
NNHML = (Rijksmuseum van Natuurlijke Historie, Leiden), National Natur Historisch Museum, Leiden;
SEM = Scanning Electro-Microscopy;
US = Università di Sassari;
MURST[1] = Ministero italiano dell'Universita' e della Ricerca Scientifica e Tecnologica;
INTERREG-UE[1] = European interregional (Sardinia-Corsica) project, European Community.

### Collections

Freshwater sponges were collected by C. Vaucher (MHNG) in 1977 and 1993 in the Lake of Neuchâtel and by B. Lods-Crozet and D. Cambin (LEBA) from 1989 to 1993 in the Lake of Geneva. Samples were obtained either by hand or by scuba diving at 31 sites along the lake borders (Lods-Crozet 1999: in the press). All specimens were identified to species level and registered for the MHNG collections. A morphological and micrometrical study of spicules and gemmules was made with *Spongilla lacustris* type material and with the collected samples of the Lakes of Geneva, Neuchâtel and River Rhône.

Measurements of mega-, micro-and gemmulo-scleres (in µm), were obtained with an compound microscope connected to a camera lucida and a Graphtec Digitizer KD 4300 (Table 1). A minimum of 20 spicules were measured.

The following additional material was studied for comparison: *Spongilla helvetica* Annandale, 1909, holotype and paratype, reg. n° MHNG-18970 INVE and MHNG-18980 INVE, Morges, Lake of Geneva, Switzerland, Collection Ostroga, respectively, 10.1900 and 07.1902; *Spongilla lacustris*, neotype designation by Penney & Racek (1968), reg. n° 1053, NNHML, Vlaardingschwaart, the Netherlands, coll. D. v. d. Kuyl, 09. 1941; *Spongilla lacustris*, det. Ezcurra de Drago, reg. n° FW 22 IZUG and FW 123

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IZUG, Bolle de Magadino, Switzerland. Sizes of mega-, micro-and gemmulo-scleres (in µm), and presence of gemmular cages and foramina were investigated (Table 2).

Spicule slides (prepared as indicated by PRONZATO & MANCONI 1989) and the SEM study were made at the MHNG. A Zeiss Digital Scan Microscope DSM 940 was used, after sputtering the samples with gold-palladium.

## RESULTS

### HABITAT AND DISTRIBUTION

Several populations (see map) of *Spongilla lacustris*, *Eunapius fragilis*, *Ephydatia fluviatilis*, and *E. muelleri* are present in the Lake of Geneva; *Trochospongilla horrida* was collected only at one locality of the Lake of Neuchâtel. *Ephydatia fluviatilis*, and *E. muelleri* were rare along the northern side of the Lake Neuchâtel (two of seven localities studied), but present on both sides of the Lake of Geneva. *Eunapius fragilis*, was present in five of nine localities of the Lake of Geneva. *Spongilla lacustris* the most common species, was widespread along the entire shoreline of the lakes of Geneva and Neuchâtel (48% of 39 sampled sites), it was very common at depths ranging from 0.2 to 3.5 m, either alone (73%) or associated with *Eunapius fragilis* (20%) or *E. fluviatilis* (13%). *Spongilla lacustris* was present, on a variety of substrata, e.g. wood piles or floating wood (34%), pebbles and boulders (20%), rocks and cliffs (18%), metallic piles (10%), brick walls and piles (8%), shells (8%) and concrete piles (2%). All the represented species are seasonal and active specimens and were found only from spring to autumn.

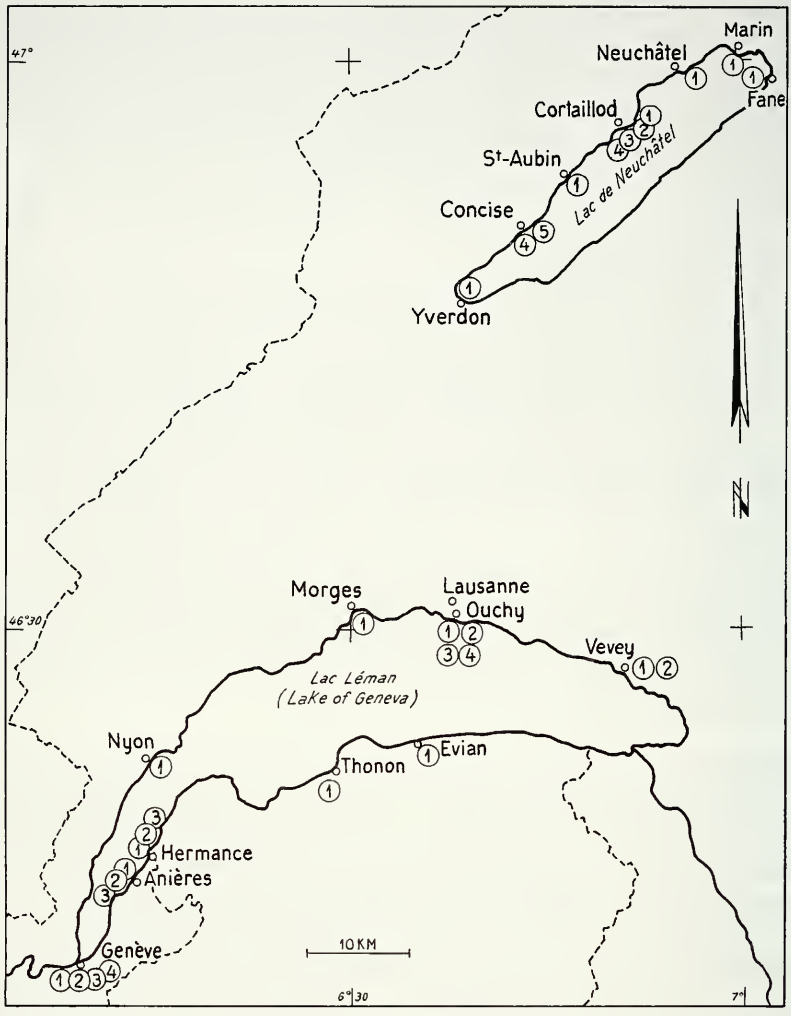
### DESCRIPTION

*Spongilla lacustris* is encrusting to massive or cushion-shape to branching. Consistence, fragile, soft. Dimensions, 2 to 70 cm. Colour, white to yellow-orange or light green; light brown or brown after fixation. Surface uneven, hispid, with irregularly scattered small oscula, covered by a fine, fragile ectosomal membrane.

Skeleton: Ectosome, short brushes of spicules, perpendicular to the surface, issued from the ends of primary longitudinal fibres. Choanosome, anisotropic network of pauci- to multi-spicular longitudinal primary fibres with a strong sheath of spongin, connected by transversal secondary pauci-spicular fibres. Skeletal meshes irregular in size and form.

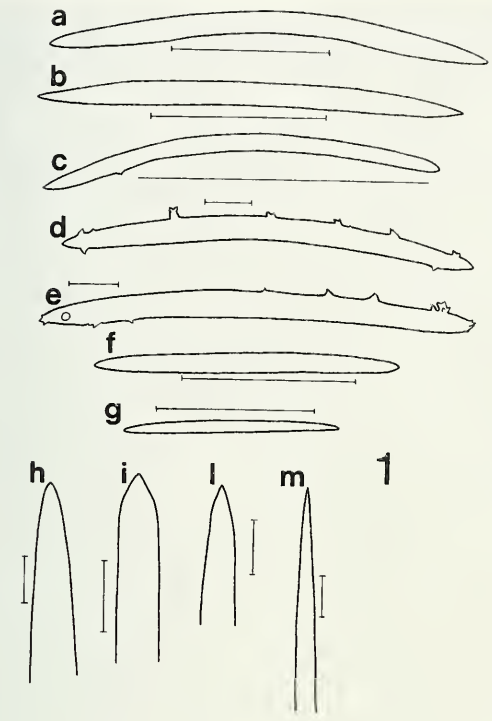
Spicules (Table 1, Figs 1-4) Megascleres oxeas, bent, fusiform with acerate or blunt, rarely hastate or conical, apices, 90-308 mm length by 2-8 µm in diameter. Some of them are slightly spined and associated to gemmules. Microscleres microxeas, bent, fusiform, strongly microspined, 25-178 µm length by 2-8 µm in diameter; they may be abundant or rare.

Gemmules: 98-789 µm in diameter, present in active sponges from March to November, in dense clusters or irregularly scattered within the skeletal framework. Gemmular shape ranged from spherical to oval and sometimes a spicular cage composed by megascleres is present. Two gemmular types were observed: either armed (with gemmuloscleres) or naked (without gemmuloscleres). Both types sometimes can




Spongillidae species presently collected at different localities in Switzerland, Lakes of Geneva and Neuchâtel. 1 = *Spongilla lacustris*; 2 = *Eunapius fragilis*; 3 = *Ephydatia fluviatilis*; 4 = *E. muelleri*; 5 = *Trochospongilla horrida*.

FIGS 1-4. *Spongilla lacustris* (L., 1759), neotype, NNML 1053, Vlaardingschwaart, the Netherlands and *Spongilla helvetica* Annandale, 1909, holotype, MHNG 18970 INVE, paratype, MHNG 18980 INVE, Morges, 1909. Fig. 1. Megascleres: smooth to slightly spined oxeas and its apical morphology. Figs 1a, c, g: *S. helvetica*, paratype; figs 1b, d, e, f, h, i, j, k: *S. lacustris*, neotype. Fig. 2. Microscleres: bent oxeas strongly microspined. Figs 2a, b, *S. helvetica*, paratype; figs 2c, d, *S. lacustris*, neotype. Fig. 3. Gemmuloscleres, variably bent oxeas, strongly microspined. Figs 3b, c, *S. helvetica*, holotype; figs 3a, d, *S. lacustris*, neotype. Fig. 4. *S. helvetica*, paratype, cage of spicules on the surface of a gemmule. Scales: Figs 1a - c, 1f, g, 2c, 4 = 100 µm; Figs 1d, e, h - k, 2a, b, d, 3a - d = 10 µm.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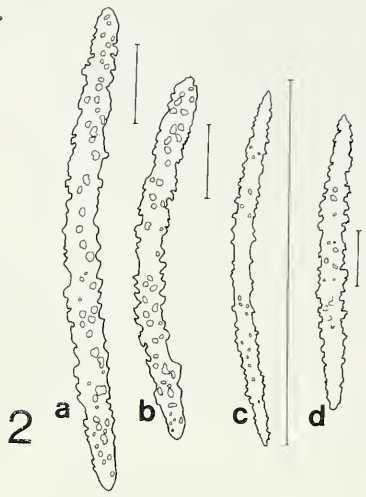
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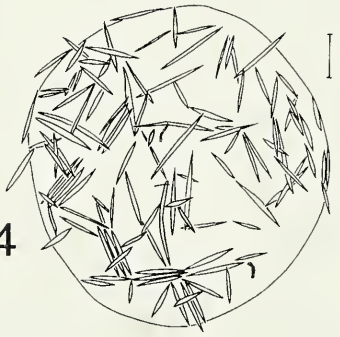
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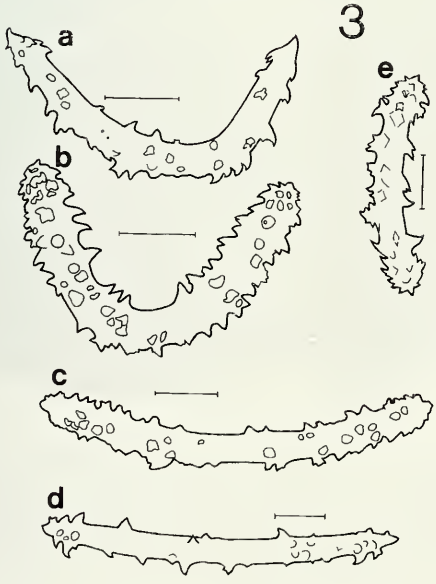
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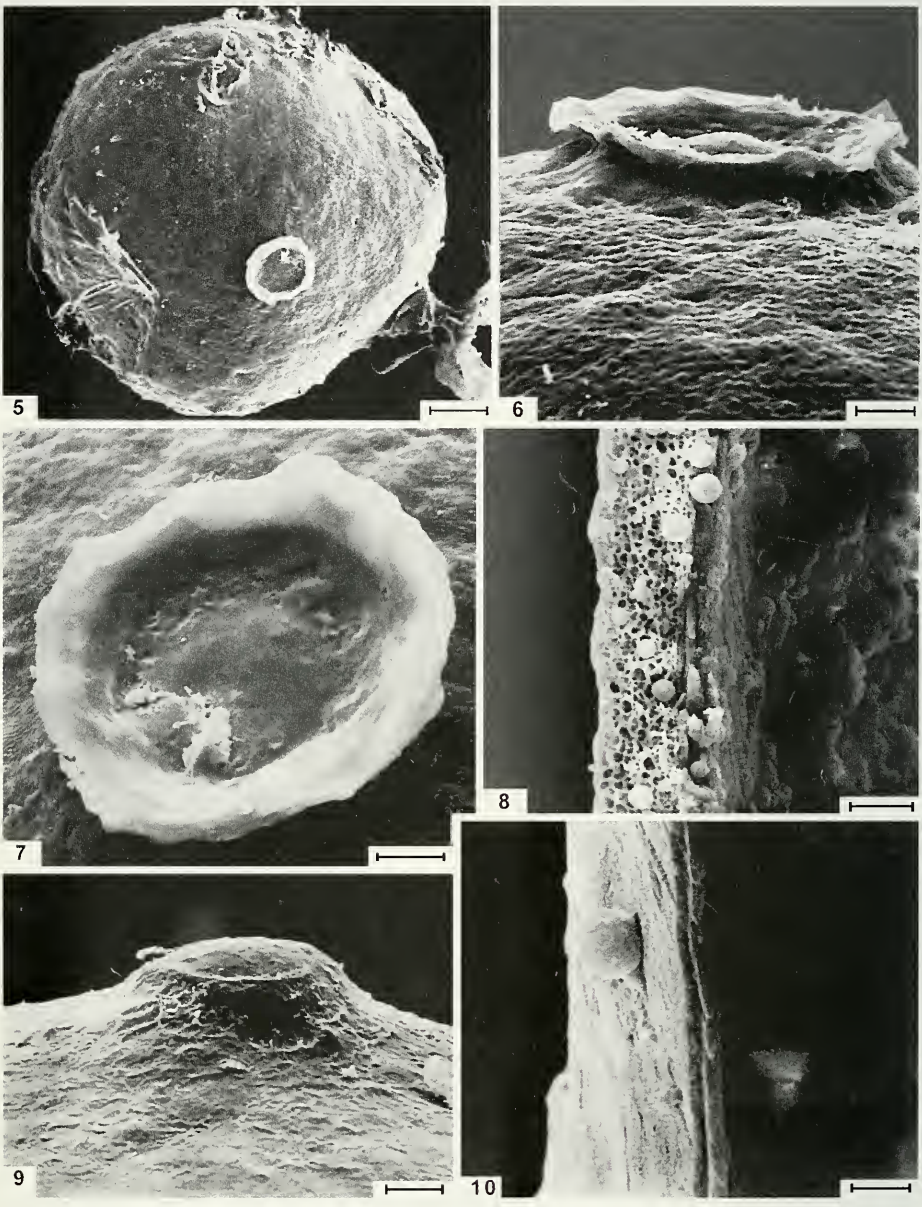
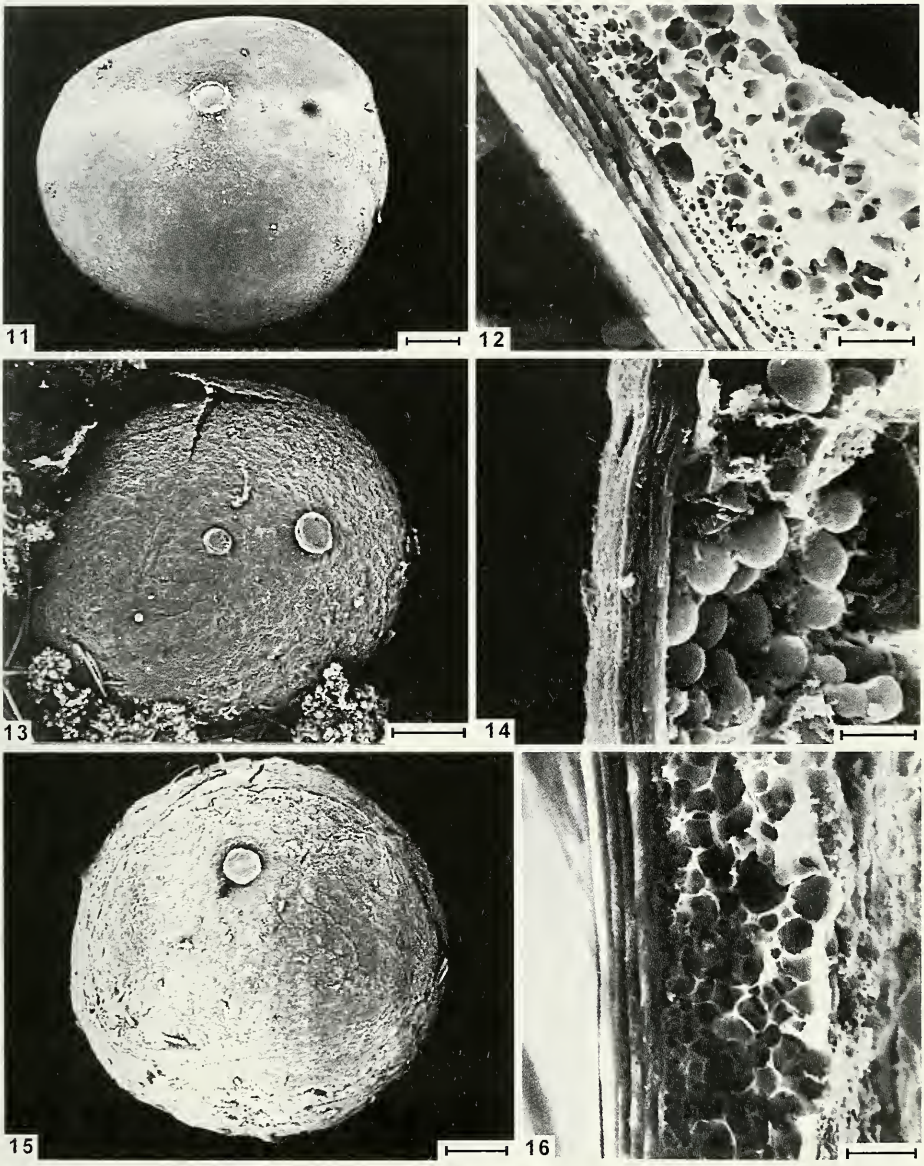



FIGS 5-10. *Spongilla lacustris* (L., 1759) neotype NNML 1053, Vlaardingschwaart, the Netherlands. Fig. 5, thick-walled gemmule, foramen with collar. Fig. 6, lateral view of the same type of foramen. Fig. 7, plate-like, enlarged frontal view of the of the same type of foramen. Fig. 8, transversal section of the theca in a thick-walled gemmule. Fig. 9, foramen without collar of a thin-walled gemmule. Fig. 10, transversal section of the theca in a thin-walled gemmule. Scales: Fig. 5 = 100 µm, Figs 6, 7, 9 = 20 µm., Fig. 8 = 10 µm; Fig. 10 = 2 µm.




FIGS 11-16. *Spongilla helvetica* Annandale, 1909, paratype. Fig. 11. Gemmule (thick-walled) with a single foramen. Fig. 12, thick gemmular theca with well developed pneumatic layer and inner coat with 5 sub-layers. Fig. 13, gemmule (thin-walled) with two foramina. Fig. 14, thin gemmular theca pneumatic layer and inner coat with 4 sub-layers. Fig. 15, gemmule with two foramina, lateral view of the second foramen, left on top. Fig. 16, gemmular theca of a gemmule with two foramina; well developed pneumatic layer and inner coat with 5 sub-layers. Scales: Figs 11, 13, 15 = 100 μm, Figs 12, 14, 16 = 5 μm.

TABLE 1

Mega, micro and gemmuloscleres; gemmule micrometries of *Spongilla lacustris* (Linnaeus, 1759) specimens presently collected from different localities of Switzerland. Micrometries refer to minimum, mean and maximum range of spicular length and diameter, and gemmular diameter, in µm.

| Locality | Megascleres | Microscleres | Gemmuloscleres | Gemmules |
|---|---|---|---|---|
| River Rhône | 163-227-290<br>3.0-4.8-6.7 | 49-69-90<br>1-2.1-4 | 44-54-64<br>2-2.4-4 | 373-469-565 |
| Lake of Geneva | 155-187-218<br>2.5-4.0-5.5 | 43-62-81<br>1-1.7-8 | 41-63-84<br>1-2.1-4 | 362-473-584 |
| Lake of Neuchâtel | 198-207-216<br>6.2-6.7-7.2 | 32-46-59<br>2-2.6-4 | 57-70-82<br>2-2.4-3.4 | 428-502-575 |

TABLE 2

Mega, micro and gemmuloscleres; gemmule micrometries; presence or not of cage and foramina number in: *Spongilla lacustris* (Linnaeus, 1758): neotype NNML 1053, Vlaardingschwaart, Netherland; *S. lacustris* in literature; *S. lacustris*, FW 22 IZUG, FW 123 IZUG, Bolle de Magadino, coll. Ezcurra de Drago; *S. lacustris* (= *Spongilla helvetica* Annandale, 1909), holotype, MHNG 18970 INVE, paratype, MHNG 18980 INVE, Morges, 1909. (*) From literature or (**) presently remeasured. Micrometries refer to minimum mean and maximum range of spicular length and diameter, and gemmular diameter, in µm. N = spicular number, stated in each case.

| Species name | Mega-scleres | Micro-scleres | Gemmulo-scleres | Gemmules | Cage | Fora-mina |
|---|---|---|---|---|---|---|
| *Spongilla lacustris* | | | | | | |
| **Neotype<br>1053 NNML | 122-273<br>x 5-16<br>n = 270 | 47-102<br>x 3-7<br>n = 50 | 35-127<br>x 3-7<br>n = 100 | 383-636<br><br>n = 22 | + | 1 |
| *Penney & Racek, 1968 | 200-350<br>x 6 - 18 | 70-130<br>x 2 - 8 | 80-130<br>x 3 - 10 | 500-800 | ? | ? |
| **FW 22 IZUG<br>Bolle de Magadino | 160-247<br>x 6-16<br>n = 22 | not<br>measured | 44-77<br>x 4-7<br>n = 20 | A | — | 1 |
| **FW 123 IZUG<br>Bolle de Magadino | 160-247<br>x 6-16<br>n = 22 | not<br>measured | 30-77<br>x 3-6<br>n = 22 | A | — | 1 or + |
| *Bolle de Magadino<br>Ezcurra de Drago, 1972 | 150-350<br>x 8-30 | 50-90<br>x 3-8 | 30-150<br>x 5-10 | A | — | — |
| **S. helvetica*<br>Annandale, 1909 | not<br>measured | not<br>measured | not<br>measured | not<br>measured | A | 1 or + |
| **Holotype<br>MHNG 18970 INVE<br>Morges | 147-241-317<br>x 5-10-18<br>n = 250 | 28-49<br>x 1-2<br>n = 12 | 51-77<br>x 2-3<br>n = 4 | 578-801<br><br>n = 11 | + | 1 or + |
| **Paratype<br>MHNG 18980 INVE<br>Morges | 115-294<br>x 4-14<br>n = 250 | 44-68<br>x 3-5<br>n = 20 | 35-99<br>x 3-7<br>n = 30 | 495-810<br><br>n = 18 | + | 1 or + |

be found in the same specimen. The coat of gemmules ranges from thick-walled with three layers (outer, pneumatic, inner layer) to thin-walled if the coat is composed only of compact spongin in a variable number (3-7) of sub-layers, in total corresponding to the inner layer of the thick walled gemmulae. A distinct horny external layer is present in some gemmules with a thick-walled theca. Thick-walled gemmules bear generally a single foramen and an irregular outer surface due to the presence of gemmuloscleres. Some gemmules with several foramina and a well developed pneumatic layer were observed. Thin-walled gemmules show generally a smooth surface and 1-6 foramina. Slightly elevated foramina without, or with a normal or plate-like collar, are irregularly present.

Gemmuloscleres: oxeas to strongyles, straight or variably curved up to a ring-shape and densely microspined, with blunt and sometimes less microspined apices. Abundant, rare or absent, according to the gemmular type concerned, 21 - 130 µm, in length by 1-4 m in diameter. Gemmuloscleres are external to or variably embedded in the gemmular theca.

## DISCUSSION

The study of *S. lacustris* from the Lake of Geneva illustrates the great variability of the taxonomic important characters, both, within the same individual or between individuals (Manconi & Pronzato 1991; Ricciardi & Reiswig 1993). Concerning the spicular and gemmular characters, we observed that thick and thin-walled thecae in gemmules can occur in the same specimen, but some specimen have one gemmular type only. The presence may, depend on the season and hence on the life cycle phase. The cage of megascleres around thin-walled gemmules is a very variable trait. We regularly observed a cage in *S. lacustris*, but it was rarely recorded by other authors (Retzer 1883; Vejdovsky 1887; Annandale 1909; Jorgensen 1946).

The comparative analysis of shape and size of *S. lacustris* recently collected from the Lake of Geneva, the neotype of *S. lacustris* and the type material of *S. helvetica*, revealed that both diagnostic characters at the spicular level (Figs 1-4), and gemmular morphology (Figs 5-16) fall within the range of *S. lacustris* Auct. This confirmed the morphological variability of *Spongilla lacustris* (Potts 1887; Vejdovsky 1887; Penney & Racek 1968; Gilbert & Simpson 1976). The morphological analysis by SEM of gemmules (Figs 5-10, 11-16) of *S. helvetica* type material and *S. lacustris* neotype, shows that the former species is indistinguishable from the later. The study of intraindividual variability (Table 1) confirms here the extremely high phenotypic plasticity of gemmular morphology. The same remark is valid for several varieties and 'morphospecies' similar to *S. lacustris*, that were described from Europe and North America based on gemmular traits (Potts 1887; Vejdovsky 1887; Penney & Racek 1968; Ezcurra de Drago 1972).

In addition, our study confirmes that the extreme variability of the gemmular structure in *S. lacustris* can be attributed to both the position of gemmules within the sponge body and to their life cycle phases as suggested by other authors (Jorgensen 1946; Gilbert & Simpson 1976).

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